# THE INHERITANCE OF INDIVIDUAL GROWTH IN CROSSBRED CHICKENS

by

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# INTRODUCTION

Broiler production has risen within the past 20 years from relative obscurity to become one of the nation's fastest growing agricultural industries. Gwin (1950) states that total broiler production for the United States in 1949 was 487 million birds, or 34 percent of the nation's chicken meat supply. This tremendous increase is, of course, due to many factors which may be briefly classified as improved broiler rations, better low-cost management practices, and genetically superior breeding stock.

Selection of the breeding stock for broiler production has, for the greater part, been on the phenotype rather than true genotype of the bird. Such a means of selection has proved to be advantageous as demonstrated by the excellent increased growth rates in today's three pound broilers at 8 to 10 weeks of age. With due respect to the methods of handling and choice of breeding stock by phenotype alone, the question has been raised as to whether the progeny test might not be applied to broiler production as it has been applied so successfully in other fields of selection.

The progeny test requires that records be kept in which both parents of the chick are recorded. A partial progeny test requires that only one parent be known specifically; the other parent may be one of a limited number of birds. The progeny test entails more labor and expense than many poultrymen wish to spend. This study was designed to test the usefulness of a partial progeny test, which could be practiced by many commercial poultrymen.

Progeny tests on a mass mating basis may be set up with either the sire known or with the dam known. In testing the sire, no trap nests need to be

used but many small mating pens are required. The number of chicks produced in such a mating depends a great deal upon the fertility of the individual parents and should a sire have poor fertility, few chicks will be produced. The second method mentioned is not limited to small pens but allows the hens to be in large breeding pens and requires only that they be trapnested.

The partial progeny test with known females was chosen for this study because: (1) the pedigree records at the College Poultry Farm were complete in respect to both family and individual bird for large numbers of hens, (2) the pullets, from which the dams to be used in this experiment were taken, had already been housed in large pens, (3) as all of these pullets were to be trapnested such a choice would make little extra work for the farm attendants, (4) the laying pens each held 250 birds which permitted the testing of large numbers of individual female breeders.

The purpose of this experiment was to measure the results obtained for growth of crossbred chicks from female breeders selected on the basis of their individual and family growth records when mass matings were practiced.

## REVIEW OF LITERATURE

Growth in the chick is a continual succession of different factors acting at various intensities throughout the life of the individual. Jull and Quinn (1925) found that chicks weigh from 61 to 68 percent of the initial egg weight. Work by Graham (1932) and Munroe and Kosin (1940) indicated that the weight of the egg and the chick are positively correlated. Kosin and Munroe (1941) also found that the male chick was 0.6 to 1.8 percent heavier at hatching than the female when body weight was expressed as a percentage of the egg weight and the influence of the family differences

was considered. This difference in male and female sibs appeared after the eighteenth day of incubation and was apparently due to the male chick embryo's greater utilization of shell calcium to accompany its heavier bone and muscle structure.

Jull (1923) was one of the first to prove that growth curves are different for male and female chicks. After the eighth week the growth of the female progresses at a relatively slower rate from week to week than does that of the male. An accumulative sum, the differences in weight at the end of any given period depend partly on differences in rate of growth during that period and partly on differences in rate of growth during the preceding periods. This difference tends to make any comparative measurements between males and females after 8 weeks misleading. Henderson (1928) analyzed data taken on 4-week-old pullets and determined that there was a highly significant correlation between the chick weight at 4 weeks and the subsequent rate of growth. That is, the chicks which were largest at 4 weeks were also largest at 8, 12, and 16 weeks. Funk, Knandel, and Callenbach (1930) arrived at these same conclusions and advocated the practice of culling the chicks on the basis of the 4-week and 8-week weights.

Upp (1928) determined that the size of the chick at hatching had little or nothing to do with its subsequent growth. Environment is a big factor in this respect and should hopper space be lacking, the smaller chicks may suffer as a result of crowding and insufficient feed.

Lerner (1937) studied the ontogenetic growth of the fowl and suggested that a uniform morphogenetic pattern controls size relationship of the parts within Gallus gallus, although bantams do not conform to this growth pattern.

Gutteridge and O'Neil (1942) stress the statistically significant importance of environmental factors as well as hereditary factors in the determination of skeletal growth up until the chicks are at least 16 weeks of age. At 24 weeks of age the environmental influence has decreased until it no longer has a significant effect, while the inheritable factors become more evident.

Asmundson and Lerner (1933) working with families of birds were able to distinguish genetic differences with respect to growth within a breed. Schnetzler (1936) found that it was possible to breed fowl for inherited growth rate differences and that these fowl could be selected at 8 or 9 weeks of age. Jaap and Morris (1937) carried out similar experiments with the selection of progenies from different sires. However, these workers disagreed on whether size, as measured at 8 weeks of age, could be considered to be associated with mature weight, or was to be considered a separate entity. Jaap and Morris stated that it is a separate entity, while Schnetzler considered that it was not.

Hess and Jull (1948) developed strains of birds with high and low feed efficiency. They were able to demonstrate definite inherent differences in feed utilization efficiency between individuals which could not be explained on the basis of body weight, rate of gain, or time. Male chicks were found to be slightly more efficient than females with the effect becoming more pronounced as the body weight increased. Crossbred chicks were more efficient in their feed utilization than the purebreds sired by the same male. Inbreeding appeared to have detrimental effects upon the efficiency of feed utilization.

That breed differences in growth rate do exist is quite evident to most poultrymen. Some breeds grow relatively faster when young and slower as

they approach maturity while other breeds grow relatively slower when young and make relatively great weight increases as they approach maturity. Asmundson and Lerner (1934) showed that breeds of the American and English classes grew more rapidly to 12 weeks of age than did breeds of the Mediterranean classes.

Leghorn cockerels supposedly grow as rapidly as, or more rapidly than males of other breeds until about the eighth week, at which time the heavier breeds surpass them. There is still some question as to whether the reduction in growth rate of the Leghorn is due to its having attained a greater proportion of its body weight during the first 8 weeks, or to other factors. A pronounced difference in the strains of Leghorns used in comparison with other breeds in weight experiments makes this a difficult question to answer.

Kempster (1941) compared New Hampshires to White Plymouth Rocks, Rhode Island Reds, and White Wyandottes, and found that the New Hampshires made the greatest gain per 4-week period up to 20 weeks of age, and also weighed more at different ages up to 40 weeks. The New Hampshires attained a higher proportion of their weight in the first 20 weeks than did the other breeds.

O'Neil and Rae (1948) designed an experiment with Barred Plymouth Rock females and males and New Hampshire males and determined that the weight of crossbred male and female chicks at hatching, when expressed as a percentage of the weight of the egg at setting time, was significantly heavier than that of Barred Plymouth Rocks. There was no significant difference between sexes within breeds, although the males in both cases were slightly heavier.

The results of Lerner, Asmundson, and Cruden (1947) show that heritability for 4 of the generally conceded characteristics of birds desirable for broiler meat production are as follows:

| Characteristic | Heritability percent |
|---|---|
| Body weight | 50 |
| Keel length | 50 |
| Length of breast | 30 |
| Width of breast | 20 |

Indexes were constructed but the impossibility of assigning proper economic weights to each of the traits studied makes such indexes of little value at the present time. However, the use of individual indexes was found to increase efficiency in rate of improvement by 10 to 14 percent.

Heritability, as defined by Shoffner and Sloan (1948) is "that fraction of the total variation associated with a characteristic which is accounted for by heredity" or, as stated by Lerner (1948), "heritability is the degree of determination by heredity of the variability of the character considered". Lerner further stated that Sewall Wright first combined the particulate inheritance of Mendel and the mathematical analysis of the biometricians, and attacked the problem of quantitative inheritance on the basis of genotype rather than on the basis of phenotype.

Emphasis in breeding work has shifted since those days. The pedigree as a criterion of worth has been replaced by the progeny test, the high record bird becoming a matter of less excitement to the research worker than a high family average. Attention is focused more on the genetic forces which grossly change the type and variability of a population than on the hypothetical single gene (so often confused with character) determining the value of an economic trait.

## MATERIALS AND METHODS

A total of 882 crossbred chicks was hatched in two lots on October 28 and November 4, 1949, from New Hampshire males mated to White Plymouth Rock females. Three large mating pens were utilized and 142 dams of both inbred and non-inbred origin were mated to males having different degrees of kinship. All chicks were wing banded and were weighed in grams at 8 weeks of age.

### Stock Used

Females. All dams used in this experiment were of the Kansas State College strain of White Plymouth Rocks in the college flock.

Approximately 250 females and 17 males were in each of the mating pens. The non-inbred female breeders used in this experiment were housed at random in 2 pens (A and C) and were mixed with other females not taking part in the experiment. The inbred female breeders were in pen B. Sixty-one dams in 17 "light" families, and 62 dams in 13 "heavy" families, plus 10 inbred dams in 5 "light" families and 9 inbred dams in 3 "heavy" families were used. These 4 groupings of 142 dams produced 689 chicks which were weighed at 8 weeks.

Males. All the New Hampshire males used in pen A were half brothers. Those in pen B were also half brothers but were not closely related to the males in pen A. Half of the males in pen C were full brothers and the rest were from other families. This division of males was planned to minimize the genetic variation contributed by sires. Such related stock would presumably have similar inheritance and would thus tend to eliminate possible variation due to preferential mating.

## Selection of Breeders

The dams used in this study were divided by families into "light" weight and "heavy" weight groups. Several inbred families were also studied. The terms "family", "light", "heavy", and "inbred" are interpreted throughout this thesis as follows:

A family - Any group of full sisters.

A light family - Any group of full sisters, the majority of whose weights at 8 weeks was 700 grams or less.

A heavy family - Any group of full sisters, the majority of whose weights at 8 weeks was 750 grams or more.

An inbred family - A group of sisters from inbred lines which were themselves inbred. Very few of the pullets had a coefficient of inbreeding of more than 38 percent. It is important to note that none of the chicks produced for the present study contained any inbreeding whatever.

The family number and dam numbers used are the same as those used in the College Poultry Farm records.

Selection of Family. The families were selected on the basis of fertility, hatchability, and number of pullets reared to maturity. The 8-week growth rate of the pullets themselves served as the basis for separating the heavy from the light weight families. The 700-gram maximum selected as the criterion for light families and the 750-gram minimum selected for the heavy families were only arbitrary figures, no actual figure having been used for dividing the families into heavy and light groups. The object was to divide the available families into the best possible groupings for this study and once a family was chosen, all the laying

females within that family were used. Some of the families could not be used because of an insufficient number of daughters, or because of too many deviations in weights of the daughters. Some of the very lightest families had been eliminated from the poultry farm; therefore, the light families as represented in this thesis are not as low as might be expected in the average flock.

Inbred families were included in the hope of obtaining evidence of hybrid vigor which might be related to the amount of inbreeding carried by the dam.

It must be clearly understood that the families were chosen from the poultry farm records on the basis of the weight of the individual sisters; therefore, the failure in a light family of some light dams to lay, when perhaps the only two heavy sisters in the family did lay, might affect the results in this study. The opposite effect might occur in a heavy family.

Light and Heavy Family Differences. The individual dams, upon which this experiment is based, are arranged in Fig. 1 by light and heavy families, according to their own 8-week weights. A mean of 702.78 grams as shown in Table 1 was computed for the families selected as light, compared to a mean of 780.64 grams for the families selected as heavy. The difference between light and heavy family means of 77.80 $\pm$ 11.74 grams is highly significant. This proves that those families which were chosen as light did weigh significantly less than those families selected as heavy.

Table 1. A comparison of weights of those dams chosen to represent the light families and the heavy families.

| Classification of family | Dams, no. | Mean wt. at 8 wks. of age, g. |
|---|---|---|
| Heavy | 62 | 780.64 $\pm$ 8.48 |
| Light | 61 | 702.78 $\pm$ 8.06 |
| Difference | | 77.86 $\pm$ 11.74**/1 |

/1 Throughout this thesis * indicates value of P = < .05 and ** indicates value of P = < .01 (highly significant).

Housing of Breeders. Full sisters may understandably be hatched at different times and thus begin to lay at different dates. The pullets in the college flock had been hatched in several lots and had been housed as their group commenced to lay. The non-inbreds laying first had been placed in pen A and their younger sisters later filled pen C. This happened to divide the family from individual dams quite evenly between the 2 pens. No other selection had been practiced in dividing the families between those pens. The laying and non-laying dams were distinguished later from their trapnest records and from the eggs as recorded for incubation. All inbreds were placed in pen B. In both inbred and non-inbred families the light and heavy families were housed together and no distinction was made between them at any time.

## Management of Chicks

Each egg was marked with the hen's number as it was removed from the trapnest. The eggs were then placed in trays for holding. All of the eggs from an individual hen were placed in a separate wire compartment during

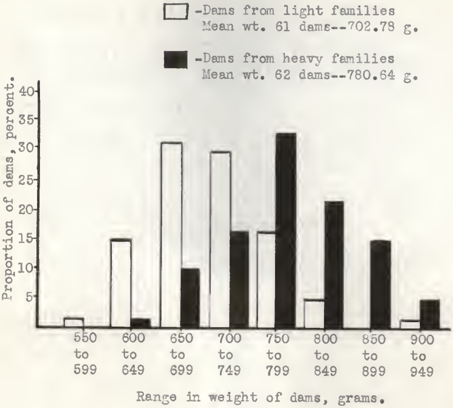


Fig. 1. A graphic representation of the 8-weeks weights of dams from "heavy" and "light" families.

incubation. Upon the twenty-second day the chicks were removed from the incubator and wing banded for identification. On October 27, 540 chicks in hatch 1 were placed under three 6-foot electric hovers in adjoining 10 x 10 foot pens in the brooder house at the College Poultry Farm. At 2 weeks of age the barriers between pens were removed and all chicks ran together. At 4 weeks of age two more 10 x 10 foot pens were opened for additional space. Hatch 1 chicks were placed on the south side of the brooder house and, as stated, occupied 5 connecting pens. On November 4, 342 chicks in hatch 2 were placed in similar pens on the opposite side of the 4-foot walkway and thus occupied adjoining pens on the north side of the same building. Hatch 2 chicks were started under 2 hovers and later allowed to run in 4 pens. As no windows were on this north side, 75-watt electric lights were placed in each pen to provide additional light. Ten-watt pilot lights burned continually under the hovers.

## Ration

The chicks were fed a "high efficiency" ration. The ration was as follows:

| Ingredients | Amount per 100 lbs. |
|---|---|
| Ground yellow corn | 65 lbs. |
| Wheat bran | 4 " |
| Dehydrated alfalfa | 1 " |
| Meat scraps | 5 " |
| Fish meal | 5 " |
| Soybean meal | 18 " |
| $CaCO_3$ | 0.5 " |
| Salt | 0.5 " |

| | |
|---|---|
| $MnSO_4$ | 15 gms. |
| Vitamin D concentrate | 40 " |
| Riboflavin | 5 " |
| Prot A | 100 " |
| Ca. Pantothenate /1 | 100 mgs. |

/1 The Ca. Pantothenate was increased to 300 mgs./100 lbs. at the end of 4 weeks, because the first hatch appeared to be suffering from a deficiency of Pantothenic acid.

Started on the regular 1 quart glass jar waterers, the chickens soon learned to drink from the automatic waterers which were present in each pen, and were never without water.

Feed was placed in the hoppers in the morning and at noon and allowed to be partially cleaned up by late afternoon, at which time they were fed enough to last until the next morning. The chicks received no grain but were reared on a mash diet throughout the experiment. The mash was fed the first 3 days on clean egg case cup flats and in chick hoppers. These hoppers were replaced by larger hoppers as the chicks grew.

## RESULTS

As previously discussed under light and heavy family differences, it would be expected that significant differences exist between the light and heavy family dams from which the crossbred chicks for this experiment were hatched. The highly significant difference between means of $77.86 \pm 11.74$ grams, as shown in Table 1, was found to exist between the light and heavy families.

## Effect of Hatch

The chicks within this experiment were divided into 2 hatches making it necessary to treat the data statistically to determine if any significant differences existed between the 2 groups hatched and reared separately. For this analysis only those dams were used which had male or female chicks or both in each hatch. The total of the chick weights at 8 weeks of age, divided as to sex, was found for each family, and the mean weight for each sex determined for that family. The mean weights thus found were used as a basis by which to compute the standard deviation and the standard error of the mean. Both inbred and non-inbred families were used.

The purpose of limiting this analysis to only those dams having male or female crossbred chicks in each group was to present a more accurate picture of the true variation, if any did exist, between the 2 lots hatched 1 week apart and reared under similar conditions. By this method of analysis, the mean difference in weight between the chicks in hatch 1 and the chicks in hatch 2 was found to be 6.01 ± 21.22 grams for the females and 4.16 ± 25.70 grams for the males, as shown in Table 2.

Table 2. A comparison of weights of chicks at 8 weeks of age in hatch 1 and hatch 2 from the same dams.

| Hatch no. | Female chicks No. | Female chicks Mean weight, g. | Male chicks No. | Male chicks Mean weight, g. |
|---|---|---|---|---|
| 1 | 29 | 711.12 ± 14.98 | 33 | 826.38 ± 17.72 |
| 2 | 29 | 705.11 ± 15.03 | 33 | 830.22 ± 18.61 |
| Difference | | 6.01 ± 21.22 | | 4.16 ± 25.70 |

It was concluded that 2 hatches as similar in weight as were these 2 could be added together for all further analysis.

## Effect of Mating Pens

The non-inbred dams were housed in pen A and pen C in the same building. Management was kept as much alike as was practically possible. Most of the families in this study had laying daughters present in both pens. The number of chicks reared from each pen was approximately equal. There were 167 female and 154 male crossbred chicks from the dams in pen A as compared to 157 female and 148 male crossbred chicks from the dams in pen C.

In attempting an unbiased selection for determination of the effect of these 2 pens, only those families were used which had 2 or more chicks of one sex reared to maturity from 1 or more dams in each of the 2 pens. This type of selection reduced the number of chicks considerably but enough families were still represented to permit an analysis. The mean difference in weights between the male chicks from light families in pen A and the male chicks from the light families in pen C was 11.69 $\pm$ 35.96 grams. The male chicks from the heavy families in pens A and C showed a mean difference of 32.89 $\pm$ 23.37 grams. The mean difference in weight between the female chicks from the light families in pen A and the light families in pen C was 29.84 $\pm$ 18.94 grams. The female chicks from the heavy families had a mean difference in weight between pens of 29.69 $\pm$ 20.05 grams. None of these differences between pens, as shown in Table 3, is statistically significant. It should be noted, however, that the crossbred chicks from the birds in pen A were in every case heavier. One possible explanation might

be that the dams in pen A, being older, had attained a better egg size, and thus gave their chicks a better start when in competition with the other chicks. The difference in weight in favor of chicks from pen A might also be traced to the males which were half brothers from a family which apparently carried genetic factors for more rapid growth than did those more numerous families of males in pen C.

Table 3. A comparison of weights of chicks at 8 weeks of age from full sisters in different mating pens.

| Classification of dams | Source of chicks/1 | Female chicks | | Male chicks | |
|---|---|---|---|---|---|
| | | No. | Mean weight, g. | No. | Mean weight, g. |
| Light | Pen A | 54 | 729.63 ± 12.86 | 35 | 828.57 ± 24.54 |
| | Pen C | 48 | 699.79 ± 13.90 | 32 | 816.88 ± 26.30 |
| Difference | | | 29.84 ± 18.94 | | 11.69 ± 35.96 |
| Heavy | Pen A | 58 | 755.17 ± 12.84 | 46 | 901.30 ± 17.90 |
| | Pen C | 62 | 725.48 ± 15.40 | 63 | 868.41 ± 15.03 |
| Difference | | | 29.69 ± 20.05 | | 32.89 ± 23.37 |

/1 Only those families having 2 or more chicks hatched from each pen were used.

## Effect of Inbred and Non-inbred Dams

Both inbred and non-inbred dams were used in this study. The mean weights of the crossbred chicks from the light and heavy families of non-inbreds were heavier than the means for the crossbred chicks from corresponding inbred families, as shown in Table 4. In 3 cases out of 4, the exception being the male chicks from the inbred light families, the mean weight of the offspring of the non-inbreds was significantly greater than

the mean weight of chicks from inbred families of corresponding weight classification. The differences were highly significant for both light and heavy families. These results were considered conclusive enough to exclude the 63 chicks from the pen of inbreds from any further analysis.

Table 4. A comparison of weights at 8 weeks of age for chicks from inbred and non-inbred dams.

| Weight classification of dams | Breeding source of chicks | Female chicks No. | Female chicks Mean weight, g. | Male chicks No. | Male chicks Mean weight, g. |
|---|---|---|---|---|---|
| Light | Non-inbred dams | 168 | 713.21 ± 7.45 | 161 | 822.86 ± 10.10 |
| | Inbred dams | 22 | 614.09 ± 27.42 | 17 | 807.65 ± 37.85 |
| Difference | | | 99.12 ± 28.39** | | 15.21 ± 38.70 |
| Heavy | Non-inbred dams | 161 | 747.45 ± 8.30 | 142 | 871.76 ± 10.37 |
| | Inbred dams | 11 | 632.73 ± 23.44 | 13 | 752.31 ± 45.07 |
| Difference | | | 114.72 ± 24.84** | | 119.45 ± 46.25* |

## Effect of Family Classification of Dam

One of the main objects in this study was to determine if any heritable weight differences might be obtained in the chicks when families selected for light and heavy 8-week weights were mated to the same males. The weights of the female chicks when arranged according to the proportion of chicks in each 50-gram weight interval (Fig. 2) demonstrate that the chicks from the light families tended to occupy a lower range of weights than the female chicks from the heavy families. A few chicks from both the light

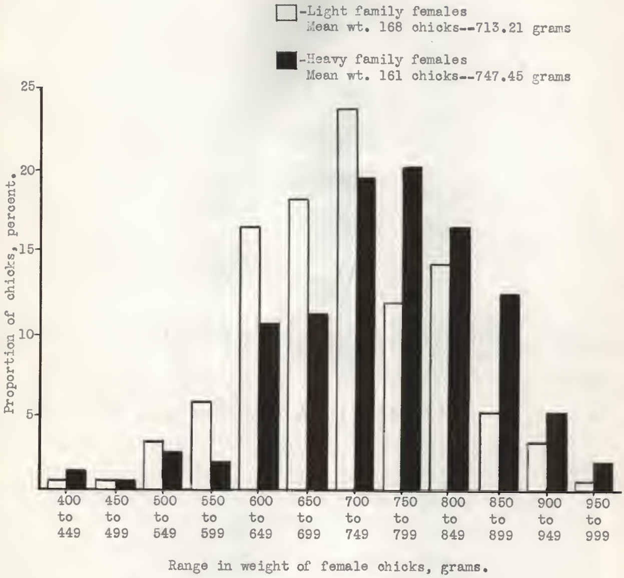


Fig. 2. A graphic representation of the 8-week weights of female chicks from dams classified as heavy and light.

weight families and the heavy weight families are represented in the extremes. The male chicks, when arranged in this same manner (Fig. 3), demonstrate the fact that the male offspring of the light families tended to occupy the lower extremes while the male offspring of the heavy families occupied the higher extremes. The weights of the female chicks ranged between 410 and 990 grams while the male chick weights ranged between 430 to 1,250 grams. The 168 female chicks from light weight families averaged 713.21 grams at 8 weeks, and 161 female chicks from heavy families averaged 747.45 grams. The difference in the mean weight between the light and heavy families was 34.24 ± 11.16 grams, a highly significant figure. The 161 male offspring of the light families averaged 822.86 grams at 8 weeks. The 142 male chicks of the heavy families averaged 871.76. This difference at 8 weeks in the mean weight between the 2 family groups of 49.10 ± 14.46 grams was also highly significant for the males. These data are summarized in Table 5.

Table 5. A comparison of weights of chicks at 8 weeks of age hatched from dams selected from families having high or low growth rates.

| Classification of dams | Female chicks | | Male chicks | |
|---|---|---|---|---|
| | No. | Mean weight, g. | No. | Mean weight, g. |
| Heavy | 161 | 747.45 ± 8.30 | 142 | 871.76 ± 10.37 |
| Light | 168 | 713.21 ± 7.45 | 161 | 822.86 ± 10.10 |
| Difference | | 34.24 ± 11.16** | | 48.90 ± 14.46** |

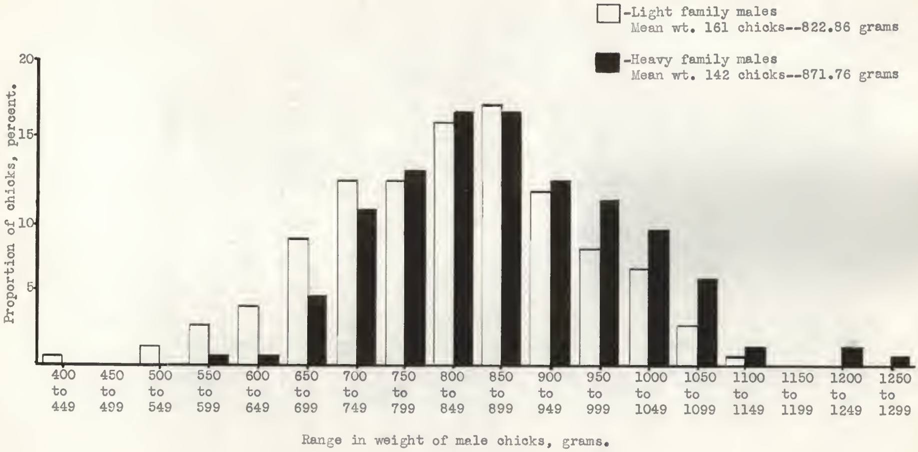


Fig. 3. A graphic representation of the 8-week weights of male chicks from dams classified as heavy and light.

## Effect of Individual Weight of Dam

The chick weights divided by sex were arranged by light and heavy families according to the 8-week weights of the dams, as separated by 50-gram intervals. This arrangement of chicks by number and by mean weight gave an erratic trend with no clear cut relationship between the weight of the chick and the weight of its dam. The chick weights from dams in the lowest and highest 50-gram weight classifications were particularly variable. A possible explanation of this deviation from the expected weight was that very few chicks were present. The few chicks were offspring of only 1, 2, or at the most 3 dams, which was an insufficient number upon which to base conclusions.

These same data regrouped upon the basis of the 8-week weights of the individual dams under 750 grams and over 750 grams showed that the heaviest half of the dams in the light families had heavier chicks than did the lightest half. The reverse was true when the heavy families were treated in the same manner, for male and female chicks of the heaviest half of the heavy family dams weighed less than the chicks from the lightest half of the heavy family, as shown in Table 6.

To determine if there was any difference in mean weight when all chicks were considered, all the dams regardless of family were regrouped according to weight at 8 weeks on the basis of those dams which weighed less than 750 grams and those which weighed 750 grams or more. In the total population, 8-week-old female chicks from dams weighing more than 750 grams averaged 25.39 grams more in weight than chicks from those dams which weighed less than 750 grams. Eight-week-old male chicks from dams which weighed more than 750 grams weighed 37.79 grams more than male chicks from dams which weighed less than 750 grams.

Table 6. A comparison of offspring at 8 weeks of age when families of breeders were divided on the basis of the dam's 8-week weight into "lightest half" and "heaviest half".

| Sex of chicks | Family classification of dams | Weight of dam/1 | | | | Difference in mean wts., g. |
|---|---|---|---|---|---|---|
| | | Heaviest half | | Lightest half | | |
| | | Chicks, no. | Mean wt., g. | Chicks, no. | Mean wt., g. | |
| Female | Light | 28 | 735.00 | 140 | 706.14 | 28.86 |
| | Heavy | 115 | 743.65 | 41 | 752.20 | Minus 8.55 |
| | Both | 143 | 741.96 | 181 | 716.57 | 25.39 |
| Male | Light | 28 | 858.57 | 133 | 815.41 | 43.16 |
| | Heavy | 105 | 870.10 | 36 | 883.33 | Minus 13.23 |
| | Both | 133 | 867.67 | 169 | 829.88 | 37.79 |

/1 Dams weighing more than 750 grams were considered as the "heaviest half" while dams weighing less than 750 grams were considered as the "lightest half".

Thus it may be concluded that the 8-week weight of the chick is related to some extent to the individual 8-week weight of the dam.

To obtain more information on the inheritance of weight in crossbred chicks the families were again divided. The chicks of the lightest sister were compared to the chicks of the heaviest sister within each family. Divided as to sex, the average 8-week weight of all chicks from the lightest sister from each of the families was compared to that for chicks from the heaviest sister of the same families. At 8 weeks of age the female chicks of the heaviest sister from heavy families averaged 34.64 grams more in weight than female chicks of the lightest sister. At 8 weeks the male chicks from the heaviest sister of the heavy families averaged 35.43 grams

more in weight than male chicks from the lightest sister. The female and male chicks from the heaviest sister in light families were heavier in weight by 3.47 grams and 31.52 grams, respectively, than chicks from the lightest sister. These data are given in detail in Table 7.

Table 7. A comparison of weights of the offspring from light and heavy families at 8 weeks of age for the lowest and highest weight dam in each family.

| Sex of chicks | Family classification of dams | Progeny hatched from | | | | Difference |
|---|---|---|---|---|---|---|
| | | Heaviest sister | | Lightest sister | | |
| | | No. | Mean wt., g. | No. | Mean wt., g. | Mean wt., g. |
| Females | Heavy | 26 | 778.08 | 32 | 743.44 | 34.64 |
| | Light | 30 | 711.33 | 28 | 707.86 | 3.47 |
| Males | Heavy | 35 | 881.43 | 20 | 846.00 | 35.43 |
| | Light | 33 | 821.52 | 23 | 780.00 | 31.52 |

## DISCUSSION

The most useful interpretation of the concept of heritability is confined to additive effects of genes. Lerner (1948) mentions that the additive action of genes is a sufficiently accurate postulate to permit the computation of expected gains for a given selection intensity. Nearly all the estimates of heritability contain this additive genetic variance and differing amounts of the variance due to dominance.

Estimates for the heritability of different factors in poultry production have been determined by various persons. These estimates are summarized

by Shoffner and Sloan (1948) as follows:

| Characteristic | Heritability, percent |
|---|---|
| Body weight | 32 - 75 |
| Egg production | 16 - 47 |
| Sexual maturity | 12 - 45 |
| Hatchability | 16 |
| Viability | 8 - 13 |

The seemingly wide differences in heritability as apparent in the above list are not due to carelessness but to the various weights put upon certain genetic traits in order to make the biological data meet the biometrical methods of approach. Most of the methods of estimating heritability depend upon the degree to which related individuals resemble each other more than do unrelated ones, thus any changes due to environment, or any error attached to the statistic during computation will affect the estimate of heritability.

No attempt was made in this brief experiment to arrive at any estimate of heritability. In the mass matings used for this experiment, it was impossible to measure the genetic contribution of the males from which the chicks were hatched. However, the significant differences in 8-week weights found to exist between the crossbred chicks from light and heavy families studied throughout this experiment indicate that dams from families having most rapid growth to 8 weeks of age transmit the most rapid rate of growth to their progeny. Analysis of these same data on the basis of the individual dam's own 8-week weight did not prove to be as practical a method of selection as the use of family records for the inheritance of rapid growth to 8 weeks of age.

## SUMMARY

The highly significant mean difference in weight between the breeders selected from 2 groups of families designated as light and heavy was $77.86 \pm 11.74$ grams. A highly significant mean difference in the weight between male chicks from the light and heavy families was $48.90 \pm 14.46$ grams. The female chicks from these 2 groups also had a highly significant mean difference in weight of $34.24 \pm 11.16$ grams. Therefore, the families selected as heavy on the basis of the number of members having high 8-week weights transmitted this weight inheritance to their progeny.

A highly significant difference in mean weight at 8 weeks of age was found to exist between the crossbred chicks from inbred and non-inbred dams. The crossbreds from inbred dams did not show evidence of greater hybrid vigor than those from non-inbred dams. They were, in fact, inferior to the crossbred chicks from non-inbred dams.

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# APPENDIX

Table 8. Tabulation of data showing family, dam, 8-week weight of dam, and average 8-week weights of male and female chicks.

| /1 Fam. no. | Dams No. | Dams Wt., g. | Females Hatch 1 No. | Females Hatch 1 Av. wt., g. | Females Hatch 2 No. | Females Hatch 2 Av. wt., g. | Males Hatch 1 No. | Males Hatch 1 Av. wt., g. | Males Hatch 2 No. | Males Hatch 2 Av. wt., g. |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 92 | 620 | 1 | 530 | | | 1 | 680 | | |
| | 559 | 800 | 4 | 695 | | | 3 | 913 | 3 | 917 |
| | 626 | 930 | 2 | 675 | | | 2 | 895 | | |
| | 633 | 630 | 4 | 680 | | | | | 3 | 807 |
| | 646 | 610 | 1 | 760 | | | 2 | 855 | 2 | 675 |
| 21 | 47 | 730 | 1 | 750 | 1 | 800 | 3 | 927 | 1 | 720 |
| | 132 | 630 | | | 1 | 780 | | | 1 | 430 |
| | 230 | 650 | 3 | 640 | 1 | 820 | 2 | 890 | | |
| | 560 | 760 | | | | | | | 1 | 640 |
| | 698 | 650 | 5 | 606 | | | 1 | 640 | | |
| | 701 | 830 | | | 1 | 560 | | | | |
| | 731 | 730 | | | 2 | 525 | | | 2 | 630 |
| 27 | 163 | 720 | 2 | 630 | | | 2 | 805 | 4 | 698 |
| | 547 | 700 | 4 | 675 | 2 | 725 | 3 | 812 | 1 | 840 |
| | 550 | 650 | | | | | 2 | 900 | | |
| | 674 | 780 | 3 | 807 | | | 2 | 865 | 2 | 790 |
| | 696 | 830 | | | 1 | 640 | 2 | 820 | 1 | 1140 |
| 31* | 19 | 740 | | | | | | | 1 | 1020 |
| | 171 | 810 | 5 | 700 | | | 1 | 870 | | |
| | 188 | 820 | 1 | 770 | 2 | 770 | 3 | 877 | 1 | 960 |
| | 196 | 720 | | | 2 | 840 | | | | |
| | 522 | 720 | | | 1 | 820 | | | 1 | 780 |
| | 529 | 750 | | | 1 | 700 | 1 | 690 | 2 | 840 |
| | 606 | 690 | 1 | 410 | | | 1 | 750 | | |
| | 607 | 750 | | | | | 1 | 1060 | | |
| | 608 | 820 | 1 | 800 | 1 | 820 | 3 | 947 | 2 | 935 |
| | 637 | 780 | 4 | 715 | | | 3 | 813 | 1 | 720 |
| | 661 | 780 | 3 | 790 | | | 3 | 827 | | |
| 32* | 108 | 750 | 4 | 705 | 2 | 700 | 2 | 880 | 1 | 880 |
| | 526 | 860 | 1 | 740 | 1 | 720 | 2 | 865 | | |
| | 622 | 700 | 2 | 625 | 2 | 760 | 2 | 880 | | |
| | 737 | 770 | | | | | | | 1 | 820 |
| 36* | 117 | 800 | 3 | 680 | 1 | 680 | 2 | 775 | 2 | 880 |
| | 561 | 870 | 1 | 670 | | | 1 | 770 | | |
| | 597 | 730 | | | 1 | 900 | | | | |
| | 667 | 680 | 3 | 647 | | | 2 | 835 | 1 | 940 |
| | 688 | 910 | | | | | 3 | 792 | | |

Table 8. (cont.).

| Fam. no. | Dams | | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Hatch 1 | | Hatch 2 | | Hatch 1 | | Hatch 2 | |
| | No. | Wt., g. | No. | Av. wt., g. | No. | Av. wt., g. | No. | Av. wt., g. | No. | Av. wt., g. |
| 38* | 28 | 730 | 4 | 732 | 2 | 935 | 1 | 1000 | 3 | 940 |
| | 128 | 680 | 3 | 715 | | | 2 | 745 | | |
| | 579 | 760 | 3 | 687 | 3 | 617 | | | | |
| | 623 | 730 | 3 | 710 | | | 1 | 840 | | |
| | 741 | 730 | 1 | 670 | 1 | 690 | 2 | 1005 | | |
| 58 | 88 | 660 | 3 | 767 | | | | | | |
| | 202 | 700 | 3 | 693 | 2 | 740 | 2 | 830 | | |
| | 668 | 720 | 2 | 710 | 1 | 780 | 4 | 785 | 1 | 900 |
| 60* | 189 | 820 | 1 | 850 | | | | | | |
| | 237 | 870 | 1 | 740 | 1 | 550 | | | | |
| | 570 | 930 | 2 | 495 | | | 1 | 890 | 1 | 780 |
| 69* | 6 | 750 | 3 | 697 | | | 2 | 855 | 2 | 990 |
| | 57 | 850 | 3 | 900 | 1 | 820 | | | | |
| | 61 | 650 | | | | | 1 | 590 | | |
| | 139 | 670 | 2 | 790 | | | 2 | 865 | 4 | 965 |
| | 556 | 840 | 2 | 700 | 1 | 860 | 3 | 1015 | 1 | 950 |
| 74 | 56 | 720 | 1 | 595 | | | 2 | 725 | 2 | 740 |
| | 68 | 710 | 1 | 810 | | | 1 | 870 | | |
| | 193 | 720 | 1 | 700 | | | 3 | 980 | | |
| | 205 | 710 | 3 | 707 | | | 4 | 796 | 5 | 880 |
| 77 | 39 | 760 | 3 | 777 | 3 | 777 | 4 | 765 | | |
| | 73 | 720 | 4 | 715 | 2 | 720 | 3 | 827 | 2 | 880 |
| | 176 | 700 | 2 | 895 | 3 | 750 | 4 | 762 | 2 | 980 |
| | 197 | 670 | 2 | 740 | | | 1 | 870 | | |
| 92 | 103 | 660 | 2 | 665 | | | 2 | 705 | 1 | 890 |
| | 161 | 740 | | | 2 | 630 | 3 | 780 | 2 | 795 |
| | 164 | 770 | 1 | 630 | | | 2 | 815 | 1 | 750 |
| | 166 | 700 | 2 | 590 | | | | | 2 | 880 |
| | 238 | 770 | 2 | 670 | | | | | | |
| 96* | 173 | 750 | | | | | 1 | 660 | | |
| | 186 | 700 | 2 | 815 | | | 2 | 875 | | |
| | 577 | 780 | | | | | | | 1 | 700 |
| | 605 | 800 | 1 | 730 | | | | | | |
| | 647 | 820 | 5 | 772 | | | 2 | 855 | 1 | 800 |
| | 654 | 870 | 4 | 805 | 2 | 880 | 3 | 1055 | 2 | 970 |

Table 8. (cont.).

| Fam. no. | Dams | | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Hatch 1 | | Hatch 2 | | Hatch 1 | | Hatch 2 | |
| | No. | Wt., g. | No. | Av. wt., g. | No. | Av. wt., g. | No. | Av. wt., g. | No. | Av. wt., g. |
| | 675 | 780 | 2 | 845 | 2 | 800 | 1 | 650 | 2 | 980 |
| | 738 | 830 | 1 | 500 | 1 | 820 | 1 | 740 | | |
| 99* | 669 | 740 | 2 | 800 | 1 | 660 | 2 | 888 | 1 | 720 |
| | 676 | 730 | | | 1 | 730 | | | | |
| 107 | 120 | 620 | 3 | 733 | 2 | 690 | 3 | 777 | 2 | 960 |
| | 179 | 730 | 1 | 700 | | | 1 | 860 | | |
| | 239 | 560 | 1 | 660 | 1 | 620 | 2 | 835 | | |
| | 638 | 610 | 3 | 680 | | | 1 | 780 | | |
| 110 | 95 | 600 | 1 | 760 | | | | | | |
| | 198 | 640 | 2 | 775 | 2 | 625 | 2 | 675 | 1 | 700 |
| In 140* | 363 | 700 | | | | | | | 1 | 740 |
| | 277 | 880 | | | 1 | 680 | | | 1 | 800 |
| | 302 | 700 | | | | | 3 | 827 | 2 | 920 |
| In 141* | 349 | 830 | | | | | 1 | 730 | | |
| | 350 | 820 | 3 | 640 | 1 | 620 | | | 2 | 740 |
| | 354 | 770 | | | | | 1 | 470 | 1 | 600 |
| | 360 | 750 | 1 | 630 | | | | | | |
| | 421 | 810 | 2 | 582 | | | 1 | 630 | | |
| In 146 | 293 | 580 | | | 1 | 660 | | | 1 | 820 |
| | 378 | 820 | 1 | 510 | 1 | 670 | 3 | 680 | 1 | 720 |
| In 149 | 267 | 690 | 1 | 780 | 1 | 790 | | | 1 | 930 |
| | 289 | 670 | 1 | 560 | 1 | 540 | 3 | 896 | 2 | 800 |
| | 298 | 740 | 5 | 534 | 1 | 640 | 1 | 700 | 1 | 960 |
| | 339 | 730 | | | | | | | 1 | 980 |
| In 153* | 290 | 590 | 1 | 740 | 2 | 600 | | | | |
| In B25 | 409 | 640 | 3 | 666 | 1 | 740 | | | | |
| In B43 | 439 | 600 | | | | | 2 | 825 | 1 | 640 |
| In B51 | 424 | 550 | 1 | 660 | | | | | | |
| | 469 | 610 | 3 | 593 | 1 | 620 | | | | |

Table 8. (cont.).

| Fam. no. | Dams No. | Dams Wt., g. | Females Hatch 1 No. | Females Hatch 1 Av. wt., g. | Females Hatch 2 No. | Females Hatch 2 Av. wt., g. | Males Hatch 1 No. | Males Hatch 1 Av. wt., g. | Males Hatch 2 No. | Males Hatch 2 Av. wt., g. |
|---|---|---|---|---|---|---|---|---|---|---|
| 210 | 142 | 690 | 4 | 735 | 2 | 765 | 2 | 925 | 1 | 730 |
| | 177 | 700 | 3 | 710 | 1 | 940 | 3 | 867 | 1 | 850 |
| | 191 | 730 | 4 | 692 | 1 | 740 | 3 | 940 | 2 | 920 |
| | 247 | 600 | | | | | 2 | 770 | | |
| | 554 | 740 | 2 | 715 | | | 1 | 870 | | |
| | 672 | 660 | 1 | 660 | | | 1 | 800 | 3 | 1040 |
| 211* | 215 | 830 | | | | | 1 | 810 | 1 | 740 |
| | 520 | 860 | 4 | 840 | 2 | 760 | 1 | 1250 | 1 | 1220 |
| 221 | 229 | 690 | | | 4 | 715 | | | 1 | 970 |
| | 525 | 750 | 3 | 727 | 2 | 820 | 1 | 740 | 2 | 990 |
| | 636 | 660 | 3 | 657 | 2 | 770 | 2 | 780 | 1 | 810 |
| | 712 | 750 | 3 | 793 | | | 1 | 850 | 1 | 1020 |
| 223 | 203 | 690 | 7 | 818 | 1 | 680 | 1 | 960 | 4 | 850 |
| | 209 | 670 | | | | | | | 1 | 840 |
| | 588 | 740 | 4 | 712 | | | 2 | 820 | 2 | 640 |
| | 700 | 670 | 1 | 680 | | | | | 1 | 680 |
| 224 | 133 | 680 | 2 | 665 | | | | | | |
| | 551 | 670 | 3 | 723 | | | 1 | 790 | 1 | 880 |
| | 616 | 670 | | | | | 1 | 650 | | |
| 228* | 137 | 790 | 3 | 770 | 1 | 620 | 1 | 760 | 3 | 910 |
| | 187 | 650 | 5 | 842 | 1 | 630 | | | 3 | 1063 |
| | 211 | 780 | 5 | 738 | | | 3 | 1010 | 3 | 910 |
| | 502 | 830 | 1 | 820 | | | 2 | 875 | | |
| | 543 | 760 | | | 2 | 785 | 3 | 818 | 1 | 970 |
| | 580 | 790 | | | | | | | 1 | 800 |
| | 615 | 840 | | | 2 | 620 | 3 | 833 | 3 | 777 |
| 232 | 707 | 700 | 3 | 690 | | | | | | |
| 233 | 566 | 660 | 1 | 730 | 1 | 760 | 1 | 710 | 1 | 800 |
| | 593 | 710 | 3 | 693 | 2 | 580 | 3 | 760 | 1 | 680 |
| | 715 | 620 | | | 3 | 763 | 1 | 880 | | |
| | 723 | 670 | 1 | 570 | 1 | 640 | 1 | 815 | | |

Table 8. (concl.).

| Fam. no. | Dams No. | Dams Wt., g. | Females Hatch 1 No. | Females Hatch 1 Av. wt., g. | Females Hatch 2 No. | Females Hatch 2 Av. wt., g. | Males Hatch 1 No. | Males Hatch 1 Av. wt., g. | Males Hatch 2 No. | Males Hatch 2 Av. wt., g. |
|---|---|---|---|---|---|---|---|---|---|---|
| 240* | 183 | 730 | | | | | 1 | 720 | | |
| | 184 | 800 | 4 | 760 | 1 | 600 | 4 | 838 | 1 | 880 |
| | 190 | 790 | 3 | 790 | 3 | 717 | | | | |
| | 192 | 840 | 3 | 800 | 1 | 730 | 4 | 830 | 2 | 750 |
| 241* | 562 | 770 | | | 1 | 860 | | | 1 | 730 |
| | 631 | 910 | 2 | 765 | | | 1 | 830 | 1 | 660 |
| | 720 | 600 | | | 1 | 840 | | | 3 | 793 |
| | 734 | 810 | | | | | 1 | 970 | | |
| 244 | 613 | 810 | 2 | 638 | 1 | 800 | 1 | 860 | 1 | 920 |
| | 670 | 750 | 4 | 778 | | | 2 | 840 | | |

/1 Throughout this table * indicates those families classified as heavy. All other families are classified as light. In indicates those families which are inbred. All families not so marked are non-inbred.

Table 9. Weights by 10-gram intervals for the individual female chicks from light families./1

| Class range (Wt. in g.) | Frequency | Freq. (dev.)$^2$ |
|---|---|---|
| 440 | 1 | 74,643.7 |
| 480 | 1 | 54,386.9 |
| 500 | 1 | 45,458.5 |
| 530 | 2 | 67,131.8 |
| 540 | 2 | 60,003.4 |
| 550 | 1 | 26,637.5 |
| 560 | 1 | 23,473.3 |
| 570 | 2 | 41,018.2 |
| 580 | 3 | 53,234.7 |
| 590 | 2 | 30,361.4 |
| 610 | 6 | 63,913.8 |
| 620 | 5 | 43,440.5 |
| 630 | 7 | 48,467.3 |
| 640 | 9 | 48,237.3 |
| 650 | 5 | 19,977.5 |
| 660 | 12 | 33,975.6 |
| 670 | 3 | 5,601.3 |
| 680 | 5 | 5,514.5 |
| 690 | 5 | 2,693.5 |
| 700 | 6 | 1,047.0 |
| 710 | 4 | 41.2 |
| 720 | 13 | 599.3 |
| 730 | 7 | 1,973.3 |
| 740 | 9 | 6,459.3 |
| 750 | 2 | 2,707.0 |
| 760 | 8 | 17,514.4 |
| 770 | 3 | 9,675.3 |
| 780 | 3 | 13,382.7 |
| 790 | 3 | 17,690.1 |
| 800 | 6 | 45,195.0 |
| 810 | 4 | 37,473.2 |
| 820 | 7 | 79,828.7 |
| 830 | 4 | 54,559.6 |
| 840 | 2 | 32,151.4 |
| 860 | 1 | 21,547.3 |
| 870 | 2 | 49,166.2 |
| 880 | 4 | 111,275.6 |
| 890 | 1 | 31,254.7 |
| 900 | 1 | 34,890.5 |
| 910 | 2 | 77,452.6 |

Table 9. (concl.).

| Class range (Wt. in g.) | Frequency | Freq. (dev.)$^2$ |
|---|---|---|
| 920 | 1 | 42,762.1 |
| 940 | 1 | 51,433.7 |
| 990 | 1 | 76,612.7 |

$$n = 168$$

$$\bar{x} = 713.21$$

$$\sigma = \sqrt{\frac{\Sigma fd^2}{n}} = 96.51$$

$$SE\bar{x} = \pm \frac{\sigma}{\sqrt{n}} = \pm 7.45$$

[1] In Table 9 through 12, the class range has been omitted when the frequency was zero.

Table 10. Weights by 10-gram intervals for the individual female chicks from heavy families.

| Class range (Wt. in g.) | Frequency | Freq. (dev.)$^2$ |
|---|---|---|
| 410 | 1 | 113,872.5 |
| 440 | 1 | 94,525.5 |
| 480 | 1 | 71,529.5 |
| 500 | 1 | 61,231.5 |
| 520 | 1 | 51,733.5 |
| 530 | 1 | 47,284.5 |
| 540 | 1 | 43,035.5 |
| 550 | 3 | 116,959.5 |
| 600 | 5 | 108,707.5 |
| 610 | 2 | 37,785.0 |
| 620 | 2 | 32,487.0 |
| 630 | 3 | 41,383.5 |
| 640 | 4 | 46,182.0 |
| 650 | 2 | 18,993.0 |
| 660 | 5 | 38,237.5 |

Table 10. (concl.).

| Class range (Wt. in g.) | Frequency | Freq. (dev.)$^2$ |
|---|---|---|
| 670 | 1 | 5,998.5 |
| 680 | 7 | 31,846.5 |
| 690 | 2 | 6,601.0 |
| 700 | 9 | 20,263.5 |
| 710 | 4 | 5,610.0 |
| 720 | 6 | 4,521.0 |
| 730 | 4 | 1,218.0 |
| 740 | 8 | 444.0 |
| 750 | 5 | 32.5 |
| 760 | 13 | 2,047.5 |
| 770 | 6 | 3,051.0 |
| 780 | 4 | 4,238.0 |
| 790 | 3 | 5,431.5 |
| 800 | 8 | 22,092.0 |
| 810 | 4 | 15,650.0 |
| 820 | 8 | 42,108.0 |
| 830 | 3 | 20,443.5 |
| 840 | 3 | 25,696.5 |
| 850 | 5 | 52,582.5 |
| 860 | 4 | 50,670.0 |
| 870 | 2 | 30,037.0 |
| 880 | 6 | 105,417.0 |
| 890 | 2 | 40,641.0 |
| 900 | 4 | 93,086.0 |
| 910 | 1 | 26,422.5 |
| 920 | 1 | 29,773.5 |
| 940 | 2 | 74,151.0 |
| 960 | 2 | 90,355.0 |
| 980 | 1 | 54,079.5 |

$n = 161$

$\bar{x} = 747.45$

$$\sigma = \sqrt{\frac{\Sigma fd^2}{n}} = 105.28$$

$$SE_{\bar{x}} = \pm \frac{\sigma}{\sqrt{n}} = \pm 8.30$$

Table 11. Weights by 10-gram intervals for the individual male chicks from light families.

| Class range (Wt. in g.) | Frequency | Freq. (dev.)$^2$ |
|---|---|---|
| 430 | 1 | 154,338.98 |
| 500 | 1 | 104,238.58 |
| 540 | 1 | 80,009.78 |
| 550 | 2 | 148,905.16 |
| 560 | 1 | 69,095.38 |
| 590 | 1 | 54,223.78 |
| 600 | 2 | 99,333.16 |
| 610 | 1 | 45,309.58 |
| 640 | 3 | 100,313.34 |
| 650 | 1 | 29,880.58 |
| 660 | 2 | 53,046.76 |
| 670 | 3 | 70,098.54 |
| 680 | 4 | 81,635.92 |
| 690 | 3 | 52,955.34 |
| 700 | 3 | 45,283.74 |
| 710 | 4 | 60,949.52 |
| 720 | 4 | 42,320.72 |
| 730 | 3 | 25,868.94 |
| 740 | 5 | 34,328.90 |
| 750 | 2 | 10,617.16 |
| 760 | 2 | 7,902.76 |
| 770 | 4 | 11,176.72 |
| 780 | 7 | 12,858.86 |
| 790 | 4 | 4,319.12 |
| 800 | 6 | 3,135.48 |
| 810 | 4 | 661.52 |
| 820 | 7 | 57.26 |
| 830 | 2 | 101.96 |
| 840 | 6 | 1,836.72 |
| 850 | 6 | 4,419.48 |
| 860 | 5 | 6,896.90 |
| 870 | 6 | 13,333.08 |
| 880 | 5 | 16,324.90 |
| 890 | 5 | 22,538.90 |
| 900 | 2 | 11,901.16 |
| 910 | 2 | 15,186.76 |
| 920 | 5 | 47,180.90 |
| 930 | 6 | 68,873.88 |
| 940 | 3 | 41,165.34 |
| 950 | 1 | 16,164.58 |
| 960 | 3 | 56,422.14 |
| 970 | 2 | 43,300.36 |
| 980 | 4 | 98,771.92 |
| 990 | 2 | 55,871.56 |

Table 11. (concl.).

| Class range (Wt. in g.) | Frequency | Freq. (dev.)$^2$ |
|---|---|---|
| 1000 | 3 | 94,135.74 |
| 1020 | 3 | 116,592.54 |
| 1030 | 1 | 42,906.98 |
| 1040 | 3 | 141,449.34 |
| 1050 | 3 | 154,777.74 |
| 1090 | 1 | 71,363.78 |
| 1140 | 1 | 100,577.78 |

$$n = 161$$

$$\bar{x} = 822.86$$

$$\sigma = \sqrt{\frac{\Sigma fd^2}{n}} = 128.17$$

$$SE\bar{x} = \pm \frac{\sigma}{\sqrt{n}} = \pm 10.10$$

Table 12. Weights by 10-gram intervals for the individual male chicks from heavy families.

| Class range (Wt. in g.) | Frequency | Freq. (dev.)$^2$ |
|---|---|---|
| 590 | 1 | 79,388.70 |
| 620 | 1 | 63,383.10 |
| 650 | 2 | 98,355.00 |
| 660 | 2 | 89,684.60 |
| 690 | 2 | 66,073.40 |
| 700 | 4 | 118.006.00 |
| 720 | 3 | 69,093.30 |
| 730 | 3 | 60,287.70 |
| 740 | 4 | 69,442.80 |
| 750 | 3 | 44,476.50 |
| 760 | 6 | 74,941.80 |
| 770 | 1 | 10,355.10 |
| 780 | 7 | 58,939.30 |
| 790 | 1 | 6,684.70 |
| 800 | 4 | 20,598.00 |

Table 12. (concl.).

| Class range (Wt. in g.) | Frequency | Freq. (dev.)$^2$ |
|---|---|---|
| 810 | 4 | 15,257.20 |
| 820 | 6 | 16,068.60 |
| 830 | 3 | 5,231.70 |
| 840 | 6 | 6,052.20 |
| 850 | 2 | 947.00 |
| 860 | 5 | 691.50 |
| 870 | 4 | 12.40 |
| 880 | 8 | 1,343.20 |
| 890 | 4 | 13,308.00 |
| 900 | 2 | 1,595.00 |
| 910 | 4 | 5,849.20 |
| 920 | 1 | 2,327.10 |
| 930 | 4 | 13,567.60 |
| 940 | 6 | 27,940.20 |
| 950 | 4 | 24,486.00 |
| 960 | 4 | 31,145.20 |
| 970 | 7 | 67,557.70 |
| 1000 | 4 | 65,782.00 |
| 1010 | 4 | 76,441.20 |
| 1020 | 2 | 42,950.20 |
| 1030 | 1 | 25,039.90 |
| 1040 | 1 | 28,304.70 |
| 1050 | 1 | 31,769.50 |
| 1060 | 2 | 70,868.60 |
| 1070 | 2 | 78,598.20 |
| 1080 | 2 | 86,727.80 |
| 1100 | 2 | 104,187.00 |
| 1220 | 1 | 121,271.10 |
| 1230 | 1 | 128,335.90 |
| 1250 | 1 | 143,065.50 |

$n = 142$

$\bar{x} = 871.76$

$$\sigma = \sqrt{\frac{\Sigma fd^2}{n}} = 123.55$$

$$SE\bar{x} = \pm \frac{\sigma}{n} = \pm 10.37$$

# THE INHERITANCE OF INDIVIDUAL GROWTH IN CROSSBRED CHICKENS

by

DANIEL KELLER ANDREWS

B. S., University of Maine, 1949

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AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Poultry Husbandry

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1951

## Purpose

The purpose of this experiment was to measure the results obtained for growth of crossbred chicks from female breeders selected on the basis of their individual and family growth records when mass matings were practiced.

## Discussion

A partial progeny test was designed such as could be practiced by a commercial poultryman. This involved the trapnesting in 3 large pens of pedigreed pullets mated to New Hampshire males.

The dams used in this study were divided by families of full sisters into "light" weight and "heavy" weight groups. Several inbred families also were studied.

In choosing the families an arbitrary average weight of 700 grams or less was selected to represent the light families while 750 grams or above was chosen to represent the heavy families. Actually the mean 8-week weight for the light dams used in this study was 702.78 grams as compared to 780.64 grams for the dams in the heavy families. This difference in the mean weights between the light and heavy families was $77.86 \pm 11.74$ grams, which is a highly significant difference in weight.

The 8-week weights of the dams themselves served as the primary basis for separating the heavy families from the light weight families. The females were also selected to some extent on the basis of fertility, hatchability, and number of pullets reared to maturity. Once a family was chosen all the dams within that family were used.

The 142 dams of the Kansas State College strain of White Plymouth Rocks were chosen from 700 pullets housed in 3 adjoining laying pens. The dams were grouped into 4 divisions as follows: 17 light families, 13 heavy

families, 5 inbred light families, and 3 inbred heavy families. The number of dams present in each group was 61, 62, 10, and 9 birds, respectively. Seventeen New Hampshire males were used in each pen. The males in pen A were half brothers. Those in pen B were also half brothers, but not closely related to those in pen A. One-half the males in pen C were unrelated, the remainder were half brothers. The large families of half brothers in pens A and B were used in an effort to minimize possible variation due to preferential matings.

All eggs were marked with the dam's number and all chicks were wing-banded. Five hundred forty chicks were hatched on October 27 (hatch 1) and 342 chicks were hatched on November 4, 1949, (hatch 2). These chicks were placed in adjoining pens in the same building and received the same feed and management.

## Results

No significant difference was found to exist between weights of chicks from hatch 1 and hatch 2 or between weights of those from pen A and those from pen C. Crossbred chicks from the inbred dams were significantly different in weight from crossbred chicks from non-inbred dams. For this reason the chicks from inbred dams were excluded from further analysis.

Highly significant differences in 8-week weight were apparent when male and female chicks from the light families were compared to chicks of similar sex from the heavy families. The difference in mean 8-week weights of female chicks from light and heavy families was $34 \pm 11.16$ grams. A comparison of male chicks from the same families resulted in a $49 \pm 14.46$ grams difference in 8-week weight. The difference in both cases was highly significant.

Chicks from the dams classified as the heaviest half of the sisters did weigh more than chicks from the dams classified as the lightest half of the sisters.

It was concluded that families selected as heavy on the basis of heavy 8-week weights transmitted this weight inheritance to their progeny. The crossbred chicks from the inbred dams in this experiment did not perform well when compared to crossbred chicks from non-inbred dams.